ALMA Early Science 2011

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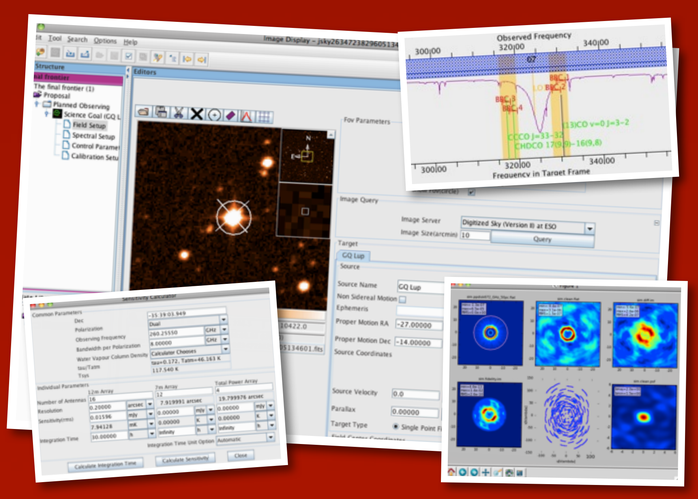
Atacama Large Millimeter-submillimeter Array (ALMA) will start scientific observation in 2011 and provide unprecedented power to address many issues of astrophysics. Even in the early science cycle0, spacial resolution (~1″) and very high sensitivity of ALMA covering frequency ranges of 84-720 GHz will tell us physical properties of solar objects, protoplanetary disks, evolved stars, star forming regions, nearby galaxies, and high-z galaxies. ALMA can also investigate Cycle 0 call for proposal will be issued at the end of March. The East-Asian ALMA Regional Center (EA-ARC) will provide user support in many aspects. We present the latest status and information for the observing proposal of ALMA.

Current status of ALMA

We have already installed 9 antenna at the high site (5000 m altitude) and are testing them as the Commissioning and Scientific Verification (CSV). More than 10 antennas are waiting on line to be added. The Early Science observation with at least 16 antennas will start in 2011 and full operation in 2012.

Softwares under testing

For the proposal submission, to calculate sensitivity and prepare observation, you



will use the ALMA Observation Tool (OT). For imaging simulation and data reduction, the Common Astronomy Software Application (CASA) will be used.

Although both softwares are under active development, you can download the current version and try these.

What can you do with ALMA?

ALMA is the world largest radio telescope being constructed in the Atacama desert, Chile. The interferometric telescope consists of 66 antennas with various receivers covering mm and submm wavelengths. It is a multi-purpose telescope targeting from nearby star-forming regions to distant galaxies. Its unprecedented high sensitivity and spatial resolution enormously benefit all the astronomical subject.

Submm astronomy

Continuum ... gas & dust thermal emission (mass/temperature), synchrotron emission

Emission/absorption line

- ***Doppler shift*** → kinematics
- ***Line emission/absorption*** → mass, chemical composition
- ***Line intensity ratio*** → (excitation) temperature

Polarization ... scattering, magnetic field, etc.

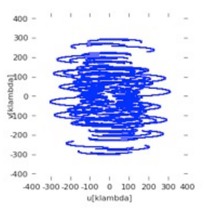
Cycle 0 Capability

Minimum Spec

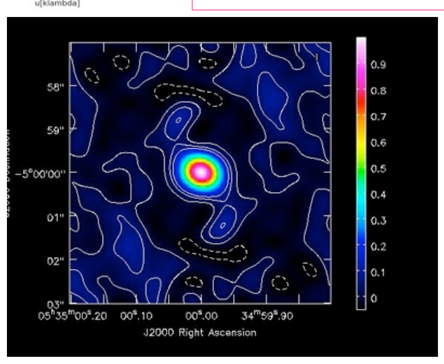
- 16 x 12m antenna array
- 18 - 250m baselines, 2 configurations
- Single field imaging
- Band 3, 6, 7, and 9 are available
- Set of ~21 spectral modes (see later)
- No subarrays, no special modes
- Amp Calibration good to 5% (band 3) and less accurate at high frequencies – 15% at band 9?

Simulated PSF of Orion

- Target: 5h35m, -5d 00m
- Observed frequency = 345 GHz
- 16 antennas with 250 m max baseline
- 8 hours integration



- beam
  FWHM(0.62”,0.73”)
  PA ~ -60deg
- side-lobe
  -6% ~ 8%
- 1σ sensitivity (2GHz BW)
  0.080mJy (2.03mK)



Resolution

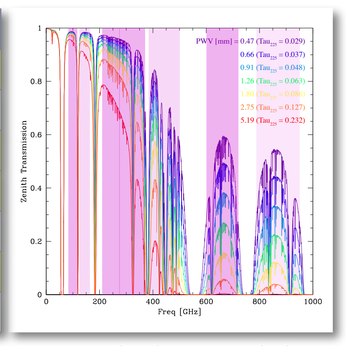
1) Spatial Resolution and Field of View

$$\text{Resolution} \cong 0.72'' \times \left[\frac{250\text{m}}{L \quad (\text{m})}\right] \times \left[\frac{345\text{GHz}}{\nu \quad (\text{GHz})}\right]$$

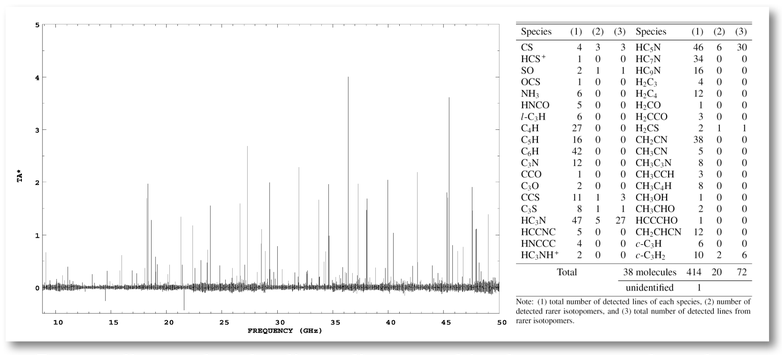
$$\text{Field of View} \approx 15'' \times \left[\frac{345\text{GHz}}{\nu \quad (\text{GHz})}\right]$$

2) Sensitivity Sensitivity $1\sigma \cong 0.23 mJy \times \left[\frac{t\,\text{sec}}{3600\,\text{sec}}\right]^{-\frac{1}{2}} \left[\frac{\nu\ GHz}{2\ GHz}\right]^{-\frac{1}{2}} @345GHz(dual\ polari)$

Band	ν (GHz)	IF (GHz)	Side bands
3	84-116	4-8	2SB
4	125-163	4-8	2SB
6	211-275	6-10	2SB
7	275-370	4-8	2SB
8	385-500	4-8	2SB
9	602-720	4-12	DSB
10	787-950	4-12	DSB



Left: ALMA receiver bands. Right: atmospheric transmission curve at the Atacama desert with different water vapor.



Species	(1)	(2)	(3)	Species	(1)	(2)	(3)
CS	4	3	3	HC_3N	46	6	30
HCS^+	1	0	0	HC_5N	34	0	0
SO	2	1	1	HC_9N	16	0	0
OCS	1	0	0	H_2C_3	4	0	0
NH_3	6	0	0	H_2C_4	12	0	0
HNCO	5	0	0	H_2CO	1	0	0
l-C_3H	6	0	0	H_2CCO	3	0	0
C_4H	27	0	0	H_2CS	2	1	1
C_3H	16	0	0	CH_2CN	38	0	0
C_6H	42	0	0	CH_3CN	5	0	0
C_3N	12	0	0	CH_3C_3N	8	0	0
CCO	1	0	0	CH_2CCH	3	0	0
C_3O	2	0	0	CH_3C_4H	8	0	0
CCS	11	1	3	CH_3OH	1	0	0
C_3S	8	1	1	CH_3CHO	2	0	0
HC_2N	47	5	27	HCCCHO	1	0	0
HCCNC	5	0	0	CH_2CHCN	12	0	0
HNCCC	4	0	0	c-C_3H	6	0	0
HC_3NH^+	2	0	0	c-C_3H_2	10	2	6
Total				38 molecules	414	20	72
				unidentified	1		

Note: (1) total number of detected lines of each species, (2) number of detected rarer isotopomers, and (3) total number of detected lines from rarer isotopomers.

Interstellar molecular lines discovered in the mm wavelength (Kaifu et al. 2004)

Schedule

The key dates in the current plans for Cycle 0 are given below. It is still possible that changes in circumstances may make it necessary to alter them.

- **31March 2011**: CfP for ALMA Early Science Cycle 0 and release of offline Observing Tool.
- 1 June 2011: Opening of archive for proposal submission.
- **30 June 2011**: Proposal Deadline.
- 30 September 2011: Start of ALMA Cycle 0 observing.
- 30 June 2012: End of ALMA Cycle 0.

Steps to get observing time

- Check the status with the Call for Proposal
- Register yourself (and your co-Is) at the ALMA user portal
- Download the Observing Tool (OT)
- Decide frequency, resolution and required sensitivity
- Input all the parameters into the OT
- Prepare scientific justification and Tchnical Case (PDF format)
- Compile and attach them to the OT
- Submit the proposal

We are planning to organise scientific workshops, OT and CASA tutorial.
(Users meeting was held last week.)

Need more information?

Contact the East Asian-ALMA Regional Center (EA-ARC) at NAOJ

http://alma.mtk.nao.ac.jp

Consult EA-ARC helpdesk if any problem

eaarc_contact@alma.mtk.nao.ac.jp

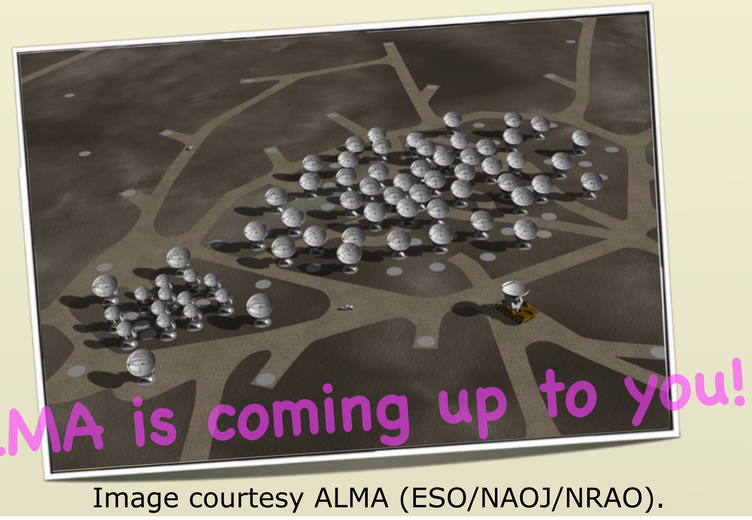


Image courtesy ALMA (ESO/NAOJ/NRAO).